# Sport-Specific Associations of Specialization and Sex With Overuse Injury in Youth Athletes

Eric G. Post, PhD, ATC,*† Kevin M. Biese, MA, ATC,‡ Daniel A. Schaefer, MS, RSCC,‡ Andrew M. Watson, MD, MS,§ Timothy A. McGuine, PhD, ATC,§ M. Alison Brooks, MD, MPH,§ and David R. Bell, PhD, ATC‡§

**Background:** Significant evidence has emerged that sport specialization is associated with an increased risk of overuse injury in youth athletes. Several recommendations exist to reduce the risk of overuse injury in youth sports, but the risk of overuse injuries may be dependent on specific movements required by a given sport.

**Hypotheses:** Associations between specialized sport participation and overuse injury will exist in volleyball athletes but not soccer or basketball athletes. Female athletes will be more likely to report an overuse injury in the previous year, regardless of sport.

**Study Design:** Cross-sectional study.

**Level of Evidence:** Level 3.

**Methods:** Youth athletes between the ages of 12 and 18 years were recruited in-person at club team tournaments, competitions, and events around the state of Wisconsin during the 2016-2017 school year. Participants were asked to complete an anonymous questionnaire that consisted of (1) participant demographics, (2) sport specialization status, (3) monthly and weekly sport volume, and (4) sport-related injury history in the previous year.

**Results:** A total of 716 youth athletes completed the questionnaire (70.8% female; mean age, 14.21 ± 1.50 years; 43.2% basketball, 19.4% soccer, 37.4% volleyball; 41.8% highly specialized; 32.3% reported overuse injury in the previous year). Sex was associated with overuse injury among basketball athletes, with female basketball athletes nearly 4 times more likely to report an overuse injury compared with male basketball athletes (odds ratio, [OR], 3.7; 95% CI, 2.1-6.6; $P < 0.001$). High specialization (OR, 2.3; 95% CI, 1.1-4.9; $P = 0.02$) and participating in a single sport for more than 8 months per year (OR, 2.0; 95% CI, 1.1-3.5; $P < 0.05$) were associated with overuse injury only among volleyball athletes.

**Conclusion:** Specialization and exceeding 8 months per year in a single sport was associated with overuse injury in volleyball, which is one of the most popular youth sports for female athletes. Specialization was not associated with overuse injury in basketball or soccer athletes. Female basketball athletes were nearly 4 times more likely to report a history of overuse injury compared with male basketball athletes. The sex of a youth athlete and the sport that he or she plays may influence the risk of overuse injury associated with sport specialization.

**Clinical Relevance:** Youth athletes, parents, and clinicians should be aware that the potential risks of specialization might vary based on the athlete's sport and sex.

**Keywords:** club sports; youth sports; female athlete; sport specialization; basketball; volleyball; soccer; overuse injury

From †School of Exercise and Nutritional Sciences, San Diego State University, San Diego, California, ‡Department of Kinesiology, University of Wisconsin–Madison, Madison, Wisconsin, and §Department of Orthopedics and Rehabilitation, University of Wisconsin–Madison, Madison, Wisconsin

*Address correspondence to Eric G. Post, PhD, ATC, School of Exercise and Nutritional Sciences, San Diego State University, 5500 Campanile Drive, San Diego, CA 92182 (email: epost@sdsu.edu).

The following author declared potential conflicts of interest: D.A.S. is a paid consultant for UBIX. This work was supported by a grant that was co-funded by the American Medical Society for Sports Medicine and American College of Sports Medicine.

DOI: 10.1177/1941738119886855

An estimated 12 million student-athletes between the ages of 5 and 22 years sustain a sport-related injury annually, leading to an estimated 20 million lost days of school and generating approximately $33 billion in injury-related medical costs.[23] Significant evidence has emerged that year-round participation in a single sport at the exclusion of other sports, also known as sport specialization, is associated with an increased risk of overuse injury in youth athletes.[2] With youth sport participation and, in particular, female sport participation rising to record levels,[10] there has been increasing concern surrounding the topic of sport specialization in the media and among medical organizations.[4,7,24] Female youth athletes are more likely to specialize, participate in a single sport at high volumes, and sustain overuse injuries compared with male youth athletes.[3,18,20,21] Therefore, athlete sex may be an influential factor in the trend of specialization and overuse injury in youth sports.

Several recommendations regarding sport participation volume have been developed in an effort to reduce the risks of overuse injury in youth sports. These recommendations include (1) limiting training/competition in a single organized sport to no more than 8 months per year,[4] (2) participating in fewer hours per week of organized sports than the athlete's age,[13] (3) participating in organized sports for fewer than 16 hours per week,[13] (4) taking 1 to 2 days off per week from organized sports participation,[4] and (5) participating in at least 1 hour of unorganized sport—or free play—for every 2 hours of organized sport participation.[12] Not following these recommendations has been associated with overuse injury in multiple broad samples of youth athletes.[12,20]

To date, most studies examining the risks of sport specialization have focused on broad cohorts of youth athletes from a wide variety of sports.[3,5,9,12,14,20] However, it is possible that the risk of overuse injuries is dependent on the specific movement profile required by a given sport. For example, athletes may be at increased risk of overuse injuries resulting from specialized, high-volume participation in more technical and repetitive sports such as tennis, baseball, or volleyball compared with sports with a more varied movement profile, such as soccer or basketball. Sport-specific examinations of specialization risks in youth sports are lacking, with 2 studies finding an association of specialization and overuse injury in youth tennis athletes[11] and youth soccer athletes[1] and another recent study finding no association in elite youth soccer players.[8]

Therefore, the primary purpose of this study was to examine sport-specific associations of sex, sport specialization, and exceeding sport volume recommendations with overuse injuries in adolescent basketball, soccer, and volleyball athletes. We hypothesized that female athletes would be more likely than male athletes to report an overuse injury in the previous year, regardless of sport. We also hypothesized that associations between specialized sport participation and overuse injury would exist in volleyball athletes but not soccer or basketball athletes.

# METHODS

## Participants

The institutional review board at the University of Wisconsin–Madison approved this study and procedures. In order to be included in the study, participants were required to be aged between 12 and 18 years and active on a youth soccer, basketball, or volleyball team within the past 12 months. Participants were recruited at club team tournaments, competitions, and events around the state of Wisconsin in the 2016-2017 school year. Participants were offered the chance to participate in the study as they passed by a booth that was staffed by the research team at the club team events, and it was not possible to accurately keep track of who had or had not been offered the questionnaire, so a response rate was not calculated. Since the questionnaire was anonymous, parents and athletes were both provided with an informational sheet describing the study before both provided oral consent to participate.

## Questionnaire

Youth sport athletes were invited to complete a self-administered and anonymous questionnaire that consisted of demographics, monthly and weekly sport volume, sport specialization status, and sport-related injury history in the previous year (Appendix 1, available in the online version of this article). Questions were developed utilizing the feedback of a panel of content-area experts and the University of Wisconsin–Madison Survey Center. Athletes were asked to report the months per year that they participated in their primary sport, to estimate their average hours per week of total organized sport participation, and average hours per week of unorganized sport participation (physical education class, playing with friends, etc).

These responses were used to classify athletes as either meeting or exceeding the various sport volume recommendations: (1) hours per week of organized sport > age, (2) hours per week of organized sport >16, (3) organized sport >5 days per week, and (4) organized sport:unorganized sport ratio >2:1. For example, athletes were considered to exceed the "more hours per week than age" recommendation if they reported participating in more organized primary sport hours per week than their numerical age. Sport specialization status was determined using a widely utilized 3-point specialization scale.[3,12,17,19,20] Athletes were asked to recall any sport-related injuries that had occurred in the previous 12 months for 12 different body regions (head, neck, back, shoulder, elbow, wrist/hand, hip, upper leg, knee, lower leg, ankle, and foot). For each body region, athletes were asked the type of injury (muscle strain, joint sprain, tendonitis, fracture, etc), the mechanism of injury (gradual onset, direct contact with another player or object, noncontact), whether they sought medical care for their injury, and the number of days of sport that they missed due to the injury. Overuse injuries were defined as gradual-onset injuries occurring during sports in the previous 12 months and requiring the athlete to seek medical care. Each

questionnaire was reviewed individually with each participant by an athletic trainer to ensure accuracy of responses according to the listed criteria.

### Statistical Analysis

Data were summarized as means and standard deviations, frequencies and proportions (%), and odds ratios (ORs) and 95% CIs. Univariate analyses (independent *t* tests and chi-square tests) were conducted to initially identify differences in sex, age, sport specialization, and sport volume recommendation adherence between participants with or without a history of overuse injury in each sport. Assumptions of normality for the independent *t* tests were determined via visual inspection of histograms and calculation of skewness/kurtosis values for age in both the overall sample and for each sport subgroup. Multivariable logistic regression analyses were utilized to examine associations between variables of interest from the univariate analysis (sex, male/female; specialization category, low/moderate/high; violation of volume recommendations, yes/no) and overuse injury in the previous year. Separate models were created for each sport, adjusting for athlete age. There was no model examining the association of sex with overuse injury for volleyball, as there were no male volleyball athletes. Statistical significance was set at 2-sided a priori $P < 0.05$, and all analyses were performed in R statistical software (R Foundation for Statistical Computing) using the following packages: "foreign," "psych," "broom," and "dplyr."

## RESULTS

Demographic characteristics for the entire sample and for each sport are presented in Table 1. Overall, 716 youth athletes met the inclusion criteria and completed the questionnaire (70.8% female; mean age, 14.21 ± 1.50 years; age range, 12-18 years; 43.2% basketball, 19.4% soccer, 37.4% volleyball). There were significant differences between the 3 sports in the distribution of participant sex, age, specialization status, and all sport volume recommendations except for organized sport to free play ratio. Volleyball athletes were more likely to (1) report an overuse injury in the previous year, (2) be highly specialized, and (3) exceed 8 months per year in their primary sport than basketball or soccer athletes. Basketball athletes were more likely to exceed hours per week recommendations than soccer or volleyball athletes (Table 1).

Differences between participants with or without a history of overuse injury for each sport are presented in Table 2. Female basketball players were more likely than male basketball players to report an overuse injury in the previous year (35.6% vs 15.0%; $P < 0.001$), but there was no difference in the frequency of overuse injury history between male and female soccer players ($P = 0.16$). Athletes reporting an overuse injury in the previous year were significantly older than those with no injury history in both basketball (14.9 ± 1.4 vs 14.5 ± 1.7; $P = 0.02$) and volleyball (14.5 ± 1.08 vs 14.0 ± 1.22; $P < 0.001$). High specialization ($P = 0.01$) and participation in a single sport for more than 8 months per year ($P = 0.001$) were only associated with overuse injury history among volleyball athletes. Overuse injury history was associated with the exceeding of weekly volume recommendations for 3 of the 4 recommendations in volleyball athletes, 3 of the 4 recommendations in soccer athletes, and 1 of the 4 recommendations in basketball athletes.

Odds ratios from the multivariable logistic regression analyses are presented in Table 3. Female basketball athletes were nearly 4 times more likely to report a previous overuse injury compared with male basketball athletes (OR [95% CI], 3.7 [2.1-6.6]; $P < 0.001$). There was no association of sex with overuse injury history in soccer athletes ($P = 0.09$). Similar to the univariate analysis, high specialization (OR [95% CI], 2.3 [1.1-4.9]; $P = 0.02$) and participating in a single sport for more than 8 months per year (OR [95% CI], 2.0 [1.1-3.5]; $P < 0.05$) were only associated with overuse injury among volleyball athletes. Similarly, participating in a sport for (1) more hours than the athlete's age (OR [95% CI], 2.0 [1.2-3.4]; $P < 0.01$), (2) for more than 16 hours per week (OR [95% CI], 2.0 [1.1-3.4]; $P < 0.05$), or (3) for more than 5 days per week (OR [95% CI], 2.1 [1.2-3.9]; $P < 0.05$) were only associated with overuse injury history among the volleyball athletes. Participating in a ratio of weekly hours in organized sport to weekly hours in free play greater than 2:1 was associated with overuse injury among soccer athletes only (OR [95% CI], 2.4 [1.0-5.5]; $P < 0.05$).

## DISCUSSION

The most important finding of this study was that the influence of sex, sport specialization, and excessive sport volume on overuse injury may be sport specific. High levels of specialization were only associated with overuse injury history in volleyball athletes and not in basketball or soccer athletes. This result aligns with the theory that sport specialization may be associated with greater risk of injury in sports that are more technical and repetitive compared with sports having a broader movement profile. These results are also in agreement with previous studies of the risks of specialization in specific sports. In a sample of 2123 elite male youth soccer athletes, there was no association between specialization and overuse injury.[8] In a separate study, specialized individual-sport athletes were more likely to report an overuse injury compared with specialized team-sport athletes.[17] Highly specialized youth tennis players are also more likely to report an injury.[11]

These findings indicate that sex may be a major factor related to the association of specialization with overuse injury that has been observed in youth sports. In this study, while specialization was not associated with overuse injury in basketball athletes, female basketball athletes were nearly 4 times as likely to report an overuse injury compared with male basketball athletes. Among soccer players, there was a trend toward female athletes being more likely than male athletes to report an overuse injury, but this association was not significant ($P = 0.09$). In a sample of 1544 high school athletes, female athletes were more likely to be highly specialized, participate at

Table 1. Participant demographics by sport[a]

| Variable | Total (N = 716) | Basketball (n = 309) | Soccer (n = 139) | Volleyball (n = 268) | *P* |
|---|---|---|---|---|---|
| Sex | | | | | <**0.001** |
| Female | 507 (70.8) | 147 (47.6) | 92 (66.2) | 268 (100) | |
| Male | 209 (29.2) | 162 (52.4) | 47 (33.8) | 0 (0) | |
| Age, y | 14.21 ± 1.50 | 14.59 ± 1.61 | 13.35 ± 1.46 | 14.22 ± 1.18 | <**0.001** |
| Overuse injury in past 12 months | | | | | <**0.001** |
| No | 482 (67.7) | 230 (75.2) | 107 (77.0) | 145 (54.3) | |
| Yes | 230 (32.3) | 76 (24.8) | 32 (23.0) | 122 (45.7) | |
| Specialization Status | | | | | **0.001** |
| Low | 160 (22.3) | 78 (25.2) | 35 (25.2) | 47 (17.5) | |
| Moderate | 257 (35.9) | 120 (38.8) | 55 (39.6) | 82 (30.6) | |
| High | 299 (41.8) | 111 (35.9) | 49 (35.2) | 139 (51.9) | |
| Primary sport >8 months/year | | | | | **0.001** |
| No | 274 (38.7) | 124 (40.3) | 68 (49.6) | 82 (31.2) | |
| Yes | 434 (61.3) | 184 (59.7) | 69 (50.4) | 181 (68.6) | |
| Hours/week organized sport > age | | | | | **0.032** |
| No | 392 (55.2) | 154 (49.8) | 78 (56.9) | 160 (60.6) | |
| Yes | 318 (44.8) | 155 (50.2) | 59 (43.1) | 104 (39.4) | |
| Hours/week organized sport >16 | | | | | **0.005** |
| No | 450 (63.4) | 175 (56.6) | 93 (67.9) | 182 (68.9) | |
| Yes | 260 (36.6) | 134 (43.4) | 44 (32.1) | 82 (31.1) | |
| Days of organized sport/week >5 | | | | | **0.001** |
| No | 484 (68.5) | 190 (61.9) | 94 (68.1) | 200 (76.3) | |
| Yes | 223 (31.5) | 117 (38.1) | 44 (31.9) | 62 (23.7) | |
| Organized sport:free play ratio >2:1 | | | | | 0.51 |
| No | 369 (52.1) | 158 (51.1) | 77 (56.6) | 134 (51.0) | |
| Yes | 339 (47.9) | 151 (48.9) | 59 (43.4) | 129 (49.0) | |

[a]Values are presented as n (%) or mean ± SD. Bold values indicate $P < 0.05$.

high volumes, and report an overuse injury compared with male athletes, both in the total sample and in a subsample of athletes from sex-equivalent sports.[18] Similarly, female athletes were more likely than male athletes to report an overuse injury at both the college and the high school levels.[21] Athlete sex may be responsible for the associations that were observed between specialization and overuse injury in volleyball athletes, as the sample of volleyball athletes in this study consisted of all female athletes. Likewise, one possible reason that a previous study of elite male soccer athletes did not find an association between specialization and overuse injury may have been the lack of female athletes in that sample.[8]

Table 2. Comparisons between noninjured and injured participants[a]

| | Overuse Injury, Basketball | | | Overuse Injury, Soccer | | | Overuse Injury, Volleyball | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | No (n = 230) | Yes (n = 76) | *P* | No (n = 107) | Yes (n = 32) | *P* | No (n = 145) | Yes (n = 122) | *P* |
| *Nonmodifiable* | | | | | | | | | |
| Sex | | | **<0.001** | | | 0.16 | | | — |
| Male | 136 (85.0) | 24 (15.0) | | 40 (85.1) | 7 (14.9) | | — | — | |
| Female | 94 (64.4) | 52 (35.6) | | 67 (72.8) | 25 (27.2) | | 145 (54.3) | 122 (45.7) | |
| Age, y | 14.5 ± 1.7 | 14.9 ± 1.4 | **0.02** | 13.3 ± 1.4 | 13.4 ± 1.5 | 0.70 | 14.0 ± 1.22 | 14.5 ± 1.08 | **<0.001** |
| *Specialization* | | | | | | | | | |
| Playing 1 sport >8 months/year | | | 0.82 | | | 0.39 | | | **0.001** |
| No | 91 (74.0) | 32 (26.0) | | 50 (73.5) | 18 (26.5) | | 57 (69.5) | 25 (30.5) | |
| Yes | 138 (75.8) | 44 (24.2) | | 56 (81.2) | 13 (18.8) | | 85 (47.2) | 95 (52.8) | |
| 3-point scale | | | 0.63 | | | 0.34 | | | **0.01** |
| Low | 58 (75.3) | 19 (24.7) | | 24 (68.6) | 11 (31.4) | | 34 (72.3) | 13 (27.7) | |
| Moderate | 87 (72.5) | 33 (27.5) | | 45 (81.8) | 10 (18.2) | | 46 (56.1) | 36 (43.9) | |
| High | 85 (78.0) | 24 (22.0) | | 38 (77.6) | 11 (22.4) | | 65 (47.1) | 73 (52.9) | |
| *Weekly sport volume* | | | | | | | | | |
| More time playing organized sports (h/wk) than age | | | 0.99 | | | 0.09 | | | **0.01** |
| No | 114 (75.5) | 37 (24.5) | | 65 (83.3) | 13 (16.7) | | 97 (60.6) | 63 (39.4) | |
| Yes | 116 (74.8) | 39 (25.2) | | 41 (69.5) | 18 (30.5) | | 45 (43.7) | 58 (56.3) | |
| Greater than 16 h/wk spent playing organized sports | | | 0.55 | | | **0.05** | | | **0.01** |
| No | 132 (76.7) | 40 (23.3) | | 77 (82.8) | 16 (17.2) | | 108 (59.3) | 74 (40.7) | |
| Yes | 98 (73.1) | 36 (26.9) | | 29 (65.9) | 15 (34.1) | | 34 (42.0) | 47 (58.0) | |
| Play organized sports on more than 5 days per week | | | 0.34 | | | **0.04** | | | **0.009** |
| No | 145 (77.1) | 43 (22.9) | | 78 (83.0) | 16 (17.0) | | 117 (58.8) | 82 (41.2) | |
| Yes | 83 (71.6) | 33 (28.4) | | 29 (65.9) | 15 (34.1) | | 24 (38.7) | 38 (61.3) | |
| Organized sport:free play ratio >2:1 | | | **0.05** | | | **0.04** | | | 0.33 |
| No | 126 (80.3) | 31 (19.7) | | 65 (84.4) | 12 (15.6) | | 76 (57.1) | 57 (42.9) | |
| Yes | 104 (69.8) | 45 (30.2) | | 40 (67.8) | 19 (32.2) | | 65 (50.4) | 64 (49.6) | |

[a]Values are presented as n (%) or mean ± SD. Dashes indicate no analysis was performed for that variable. Bold values indicate $P < 0.05$.

Table 3. Odds ratios for sport specialization and sport volume by sport[a]

| | History of Overuse Injury, Basketball | History of Overuse Injury, Soccer | History of Overuse Injury, Volleyball |
|---|---|---|---|
| Sex | | | |
| Male | — | — | — |
| Female | 3.69 (2.05-6.62)*** | 2.26 (0.88-5.80) | — |
| Sport specialization | | | |
| Sport specialization scale | | | |
| Low | — | — | — |
| Moderate | 1.01 (0.50-2.03) | 0.51 (0.19-1.41) | 1.80 (0.81-3.99) |
| High | 0.89 (0.43-1.87) | 0.63 (0.23-1.73) | 2.31 (1.09-4.88)* |
| Training for more than 8 months/year | | | |
| No | — | — | — |
| Yes | 0.86 (0.49-1.50) | 0.66 (0.29-1.50) | 1.96 (1.08-3.53)* |
| Weekly sport volume | | | |
| More hours per week than age | | | |
| No | — | — | — |
| Yes | 1.06 (0.61-1.83) | 1.98 (0.86-4.57) | 2.02 (1.21-3.37)** |
| Organized sport >16 hours per week | | | |
| No | — | — | — |
| Yes | 1.24 (0.70-2.18) | 2.25 (0.97-5.23) | 1.95 (1.14-3.36)* |
| Organized sport >5 days per week | | | |
| No | — | — | — |
| Yes | 1.18 (0.67-2.06) | 2.28 (0.98-5.30) | 2.13 (1.17-3.86)* |
| Organized sport:free play ratio >2:1 | | | |
| No | — | — | — |
| Yes | 1.53 (0.88-2.66) | 2.37 (1.02-5.51)* | 1.23 (0.75-2.03) |

[a]All models for basketball and soccer were adjusted for age and sex, while all models for volleyball were adjusted for age. Sport specialization models were additionally adjusted for hours per week of sport participation. Values are reported as odds ratios (95% CI). Dashes indicate reference category. For volleyball athletes, no analysis was conducted for sex as there were no male volleyball athletes.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

Similar to the sport-specific associations of specialization with overuse injury, exceeding months per year and hours per week recommendations was associated with overuse injury in volleyball athletes but not basketball or soccer athletes. The only exception was exceeding an organized sport to free play participation ratio of 2:1, which was linked with overuse injury in soccer but not basketball or volleyball. The sport-specific nature of these results may again indicate that either athlete sex or the nature of the involved sport may influence overuse injury risk. Sports that are more repetitive and limited in their movement profile, such as volleyball, may be more susceptible to excessive sport volume. There is significant evidence that excessive sport volume is responsible for the increased risk of injury in baseball pitching, which is also highly technical and repetitive in nature.[6,15,16] Because of the nature of this study, it was not possible to determine whether it was the sex of the

volleyball athletes, the nature of the sport itself, or some combination of those 2 factors that was responsible for the associations with overuse injury. Future volleyball-specific examinations of injury are critically needed, as volleyball is the most popular female high school team sport, with nearly half a million female participants in the United States.[10] It should also be noted that the sport volume recommendations examined in this study were established as risk factors in broad samples of youth athletes from a wide variety of sports.[3,12,20,22] This may be the first study to compare the associations of these recommendations with overuse injury between specific sports.

### Limitations

This study has several limitations to note. Because of the cross-sectional nature of this study, it was not possible to report associations and draw conclusions regarding causality. It is possible that a previous injury could result in a decision to specialize rather than specialization leading to an overuse injury. However, previous prospective research has established specialization as an independent risk factor for overuse injury among adolescent athletes.[14] Additionally, all variables examined in this study were measured via self-report, creating the possibility of recall bias. For example, participants who reported an overuse injury may have been counseled by a medical provider regarding their sport participation volume or degree of specialization and may have thus been more accurate in their reporting of these variables. The potential for recall bias was limited by having each questionnaire reviewed individually with each participant by an athletic trainer. Our working definition of overuse injury for this study may have excluded many overuse injuries that were not severe enough to require the athlete to seek medical care. We were not able to determine a response rate due to the data collection strategy used for this study. Dividing this sample into 3 groups and analyzing those groups separately resulted in some groups becoming small. For example, there were only 32 overuse injuries in the soccer subgroup, which may have resulted in overfitting the models and limited the ability to identify true relationships. Finally, this sample consisted of youth athletes from just 3 sports who were all recruited at events and competitions occurring in 1 state, and the sample was mostly female (71%) and included no male youth volleyball athletes.

## CONCLUSION

The sex of a youth athlete and the sport that he or she plays may influence the risk of overuse injury associated with sport specialization. Specialization and excessive sport volume are associated with overuse injury in volleyball, which is one of the most popular youth sports for female athletes. Given the recent reductions in physical education offered in school, children are increasingly required to pursue adequate physical activity through community offerings and private sport organizations. Their choices regarding safe sport participation can have significant impacts on childhood health and the transition into an active, healthy lifestyle.

## REFERENCES

1. Bell DR, Lang PJ, Valovich McLeod TC, McCaffrey KA, Zaslow TL, McKay SD. Sport specialization is associated with injury history in youth soccer athletes. *Athl Train Sport Health Care*. 2018;10:241-246.
2. Bell DR, Post EG, Biese K, Bay C, Valovich McLeod T. Sport specialization and risk of overuse injuries: a systematic review with meta-analysis. *Pediatrics*. 2018;142:e20180657.
3. Bell DR, Post EG, Trigsted SM, Hetzel S, McGuine TA, Brooks MA. Prevalence of sport specialization in high school athletics: a 1-year observational study. *Am J Sports Med*. 2016;44:1469-1474.
4. Brenner JS; Council on Sports Medicine and Fitness. Sports specialization and intensive training in young athletes. *Pediatrics*. 2016;138:154-157.
5. Buckley PS, Bishop M, Kane P, et al. Early single-sport specialization: a survey of 3090 high school, collegiate, and professional athletes. *Orthop J Sport Med*. 2017;5:2325967117703944.
6. Chalmers PN, Sgroi T, Riff AJ, et al. Correlates with history of injury in youth and adolescent pitchers. *Arthroscopy*. 2015;31:1349-1357.
7. DiFiori JP, Benjamin HJ, Brenner JS, et al. Overuse injuries and burnout in youth sports: a position statement from the American Medical Society for Sports Medicine. *Br J Sports Med*. 2014;48:287-288.
8. Frome D, Rychlik K, Fokas J, Chiampas G, Jayanthi N, LaBella C. Sports specialization is not associated with greater odds of previous injury in elite male youth soccer players. *Clin J Sport Med*. 2019;29:368-373.
9. Hall R, Barber Foss K, Hewett TE, Myer GD. Sport specialization's association with an increased risk of developing anterior knee pain in adolescent female athletes. *J Sport Rehabil*. 2015;24:31-35.
10. High school sports participation increases for 29th consecutive year. National Federation of State High School Associations. 2018. https://www.nfhs.org/articles/high-school-sports-participation-increases-for-29th-consecutive-year/. Accessed September 4, 2018.
11. Jayanthi N, Dechert A, Durazo R, Dugas L, Luke A. Training and sports specialization risks in junior elite tennis players. *J Med Sci Tennis*. 2011;16:14-20.
12. Jayanthi NA, LaBella CR, Fischer D, Pasulka J, Dugas LR. Sports-specialized intensive training and the risk of injury in young athletes: a clinical case-control study. *Am J Sports Med*. 2015;43:794-801.
13. LaPrade RF, Agel J, Baker J, et al. AOSSM early sport specialization consensus statement. *Orthop J Sport Med*. 2016;4:2325967116644241.
14. McGuine TA, Post EG, Hetzel SJ, Brooks MA, Trigsted S, Bell DR. A prospective study on the effect of sport specialization on lower extremity injury rates in high school athletes. *Am J Sports Med*. 2017;45:2706-2712.
15. Norton R, Honstad C, Joshi R, Silvis M, Chinchilli V, Dhawan A. Risk factors for elbow and shoulder injuries in adolescent baseball players: a systematic review. *Am J Sports Med*. 2019;47:982-990.
16. Olsen SJ, Fleisig GS, Dun S, Loftice J, Andrews JR. Risk factors for shoulder and elbow injuries in adolescent baseball pitchers. *Am J Sports Med*. 2006;34:905-912.
17. Pasulka J, Jayanthi N, McCann A, Dugas LR, LaBella C. Specialization patterns across various youth sports and relationship to injury risk. *Phys Sportsmed*. 2017;45:344-352.
18. Post EG, Bell DR, Trigsted SM, et al. Association of competition volume, club sports, and sport specialization with sex and lower extremity injury history in high school athletes. *Sports Health*. 2017;9:518-523.
19. Post EG, Thein-Nissenbaum JM, Stiffler MR, et al. High school sport specialization patterns of current Division I athletes. *Sports Health*. 2016;9:148-153.
20. Post EG, Trigsted SM, Riekena JW, et al. The association of sport specialization and training volume with injury history in youth athletes. *Am J Sports Med*. 2017;45:1405-1412.
21. Roos KG, Marshall SW, Kerr ZY, et al. Epidemiology of overuse injuries in collegiate and high school athletics in the United States. *Am J Sports Med*. 2015;43:1790-1797.
22. Rose MS, Emery CA, Meeuwisse WH. Sociodemographic predictors of sport injury in adolescents. *Med Sci Sports Exerc*. 2008;40:444-450.
23. Simon JE, Wikstrom EA, Grooms DR, Docherty CL, Dompier TP, Kerr ZY. Athletic training service characteristics for patients with ankle sprains sustained during high school athletics. *J. Athl. Train*. 2019;54:676-683.
24. Valovich McLeod TC, Decoster LC, Loud KJ, et al. National Athletic Trainers' Association position statement: prevention of pediatric overuse injuries. *J Athl Train*. 2011;46:206-220.